These represent in the rock—

p. c. of (SiO_4) combined in ortho-silicates	22.67
p. c. of (SiO_3) combined in mono-meta-silicates	28.12
Total	50.79

It is interesting to note in conclusion that the rational formula calculated for labradorite according to the modern chemical system and which regards this mineral as one of the para-silicates is

$$(Ca^{ii}\ Al_2^{vi})^{viii}\ (Si_3^{iv}\ O_{10}^{ii})^{viii}.$$

This might be viewed as a *mixed* ortho- and mono-meta-silicate* in which there are two molecules of the radical (SiO_4) and one of (SiO_3). In the latter one of the atoms of O is employed in saturating alone, and the proportion which this bears to the total amount of oxygen in both radicals is evidently 1 : 11.

In Pyroxene all the silica is present as mono-meta silicic acid.

In a mixture containing exactly one molecule each of Labradorite and Pyroxene, there would then be :

	Orthosilicic Acid.	Mono-meta-silicic Acid.
Labradorite	2	1
Pyroxene		1
	2	2

That is, the number of molecules of Ortho- and Mono-meta-silicic acid would be equal, or if the p. c. by weight of the latter were as above supposed, 22.67 in the rock, that of the latter would be in such a mixture, 27.17 p. c. which is very nearly that actually given.

On the Total Solar Eclipse of July 29th, 1878.

By George F. Barker.

(*Read before the American Philosophical Society, Nov. 15th, 1878.*)

The purpose of the present paper is to put on record in the Proceedings of the Society some account of the observations made by certain of its members upon the total solar eclipse of the 29th of July, 1878.

The expedition was organized in June, by Professor Henry Draper of New York, out of compliment to whom, his associates named it the Draper Eclipse Expedition. The party consisted of Dr. Draper as Director, with Mrs. Draper as assistant, who were in charge of the photographic and photospectroscopic work, as also of the observations with the slitless spectroscope ; of President Morton, of Hoboken, to whom was confided the general observations, as well as those with the polariscope and pocket spectroscope ; of Dr. Thomas A. Edison, of Menlo Park, who was to use his newly invented tasimeter. in order to determine whether it was

*See "Tables for the determination of minerals," Frazer. 1874.

possible to measure the heat of the corona; and of myself, who was to observe with the analyzing spectroscope with the especial object of ascertaining the presence either of bright or of dark (Fraunhofer) lines in the spectrum of the corona.

Rawlins, Wyoming Territory, had been selected by the Director as the observing station, because while it was near the central line of totality, it was also easily accessible, being on the Union Pacific Railroad, was a place of some size, having eight or nine hundred inhabitants, and was the location of the railroad repair shops of the Laramie division, so that in case of need, assistance in constructing or repairing our instruments could be had. Moreover, it had a bountiful supply of excellent water brought in pipes from the neighboring Cherokee mountain, which being of granite, yielded a pure product of inestimable value for purposes of photography. Previous experience in that region of country too, had assured Dr. Draper that the air there was dry, and hence that the chances of clear weather on the day of the eclipse were very considerable.

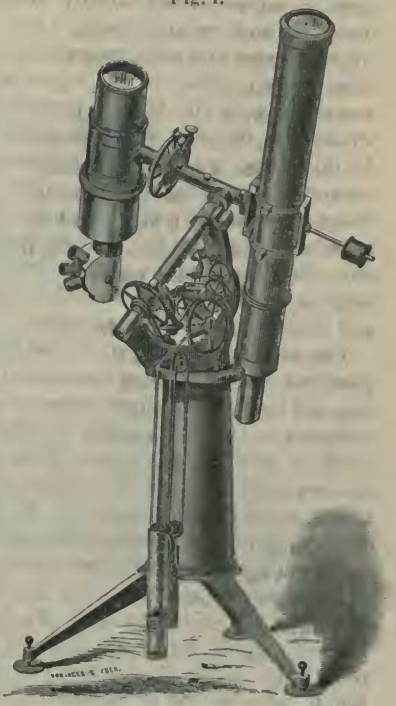
The expedition left New York on the evening of the 13th of July; and, resting by the way at Chicago for a day, reached Rawlins at mid-night of the 18th. The apparatus and material, which had been sent on by express in advance, had already arrived and in apparently good order, though in all it weighed nearly a ton, After a day's reconnoitering, plans were perfected and arrangements made for the construction of a temporary observatory in which to shelter the larger instruments. An excellent site was selected by Dr. Draper, protected in great measure from the strong winds from the west which at times sweep over those mountain plains. In this building the telespectroscopes were erected, a portion of it being converted into a photographic dark room, and supplied with running water from the hydrant. The location of this observatory was determined to be latitude 41° 48′ 50″ N., longitude 2 h. 0 m. 44 s. W. from Washington. Its altitude above the sea level was 6,732 feet. The tasimeter telescope of Dr. Edison was erected in an adjoining building, facing the west and about ten or fifteen feet distant.

The ten days of time which had been allowed for completing the preparations was found to be none too much. During a large portion of every day and most of the night, some or all of the party were engaged in adjustment of the instruments, in practice with them, in determining positions in photographic work, or in the numberless details necessary to success. On the night of the 24th, we were joined by the English astronomer, J. Norman Lockyer, F. R. S., and also by Professor James C. Watson, of the University of Michigan. Mr. Lockyer's work being mostly photographic, he was efficiently aided by Mr. J. B. Silvis, the owner of a photographic car traveling over the Union Pacific Railroad, which chanced at that time to be in Rawlins. Mr. Silvis not only most generously placed himself and his car at Mr. Lockyer's disposal for any experimental purposes entirely free of expense, but on the day of the eclipse, he allowed him to take the car to Separation, about thirteen miles distant, assisted him in observing, and returned with him to Rawlins the same evening.

The day of the eclipse was all that could be desired. The sky was almost without a cloud throughout, and the dew point was found to be at least 34° F. below the temperature of the air. The entire programme of observations was carried out as it had been arranged, and with singularly good fortune. "The results obtained," as summarized by Dr. Draper, "were: 1st, the spectrum of the corona was photographed and shown to be of the same character as that of the sun and not due to a special incandescent gas; 2d, a fine photograph of the corona was obtained, extending in some parts to a height of more than twenty minutes of arc, that is, of more than 500,000 miles; 3d, the Fraunhofer dark lines were observed by both Professors Barker and Morton in the corona; 4th, the polarization was shown by Professor Morton to be such as would answer to reflected solar light; and 5th, Mr. Edison found that the heat of the corona was sufficient to send the index beam of light entirely off the scale of the galvanometer." As these results seem to be of very considerable importance, it appears desirable to give the various methods of observation somewhat more in detail, adopting for the purpose so far as possible the language of the observers themselves, as given in their several reports.

Photographic and Phototelespectroscopic Observations.

Fig. 1.



The instruments which were used by Dr. Draper in his photographic and phototelespectroscopic observations were: "1st. An equatorial mounting, with spring governor driving clock, loaned by Professor Pickering, Director of Harvard Observatory. 2d. A telescope of five and a quarter inches aperture and seventy-eight inches focal length, furnished with a lens specially corrected for photography, by Alvan Clark & Sons. 3d. A quadruple achromatic objective of six inches aperture and twenty-one inches focal length, loaned by Messrs. E. & H. T. Anthony, of New York; to this lens was attached a Rutherford diffraction grating nearly two inches square, ruled on speculum metal. This arrangement (Fig. 1.) with its plate holders, etc., will be designated as a phototelespectroscope. Besides these there was a grating spectroscope, an eye slitless prism

spectroscope, with two inch telescope, and finally a full set of chemicals for Anthony's lightning collodion process, which in my experience is fully three times quicker than any other process."

"The arrangement of the phototelespectroscope requires farther description, for success in the work it was intended to do, viz., photographing the diffraction spectrum of the corona, was difficult and in the opinion of many of my friends impossible. In order to have every chance of success it is necessary to procure a lens of large aperture and the shortest attainable focal length, and to have a grating of the largest size adjusted in such a way as to utilize the beam of light to the best advantage. Moreover, the apparatus must be mounted equatorially and driven by clockwork so that the exposure may last the whole time of totality and the photographic work must be done by the most sensitive wet process. After some experiments during the summer of 1877 and the spring of 1878, the following form was adopted.

"The lens being of six inches aperture and twenty-one inches focal length, gave an image of the sun less than one-quarter of an inch in diameter and of extreme brilliancy. Before the beam of light from the lens reached a focus it was intercepted by the Rutherford grating set at an angle of sixty degrees. This threw the beam on one side and produced there three images—a central one of the sun and on either side of it a spectrum; these were received on three separate sensitive plates. One of these spectra was dispersed twice as much as the other, that is, gave a photograph twice as long. This last photograph was actually about two inches long in the actinic region. If, now, the light of the corona was from incandescent gas giving bright lines which lay in the actinic region of the spectrum, I should have procured ring-shaped images, one ring for each bright line. On the other hand, if the light of the corona arose from incandescent solid or liquid bodies, or was reflected light from the sun I was certain to obtain a long band in my photograph answering to the actinic region of the spectrum. If the light was partly from gas and partly from reflected sunlight a result partly of rings and partly a band would have appeared.

"Immediately after the totality was over and on developing the photographs, I found that the spectrum photographs were continuous bands without the least trace of a ring. I was not surprised at this result, because during the totality I had the opportunity of studying the corona through a telescope arranged substantially in the same way as the phototelespectroscope and saw no sign of a ring.

"The plain photograph of the corona taken with my large equatorial on this occasion shows that the corona is not arranged centrally with regard to the sun. The great mass of the matter lies in the plane of the ecliptic but not equally distributed. To the eye it extended about a degree and a half from the sun toward the west, while it was scarcely a degree in length toward the east. The mass of meteors, if such be the construction of the corona, is therefore probably arranged in elliptical form round the sun.

"The general conclusion that follows from these results is that on

this occasion we have ascertained the true nature of the corona, viz: it shines by light reflected from the sun by a cloud of meteors surrounding that luminary, and that on former occasions it has been infiltrated with materials thrown up from the chromosphere, notably with the 1474 matter and hydrogen. As the chromosphere is now quiescent this infiltration has taken place to a scarcely perceptible degree recently. This explanation of the nature of the corona reconciles itself so well with many facts that have been difficult to explain, such as the low pressure at the surface of the sun, that it gains thereby additional strength."

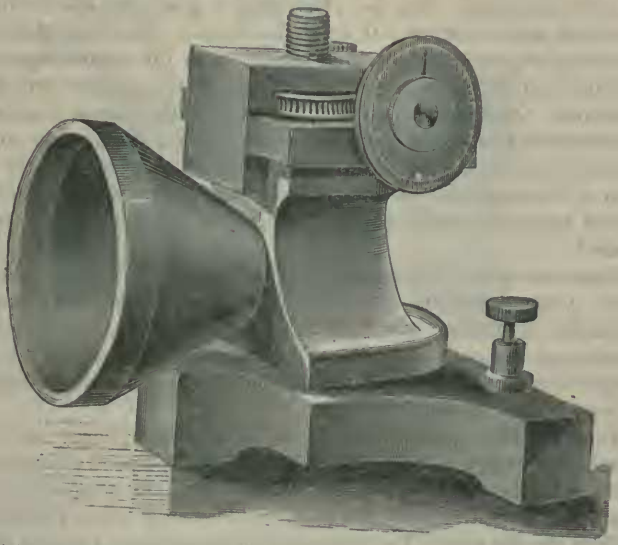
Tasimetric Observations.

As this eclipse is the first in which any attempt has been made to measure the heat of the solar corona, Dr. Edison's report to Dr. Draper on this subject is here quoted in full. He says:

"The instrument which I used at Rawlins, Wyoming, during the solar eclipse of July 29th, 1878, for the purpose of measuring the heat of the sun's corona, was devised by me a short time only before that event, and the time was insufficient to give it as thorough a test as was desirable to ascertain its full capabilities and characteristics.

"This instrument I have named the tasimeter, from the Greek words, *τασις*, extension, and *μετρον*, measure, because primarily the effect is to measure extension of any kind. The form of instrument which I used is shown in the annexed wood cut (Fig. 2.)

Fig. 2.

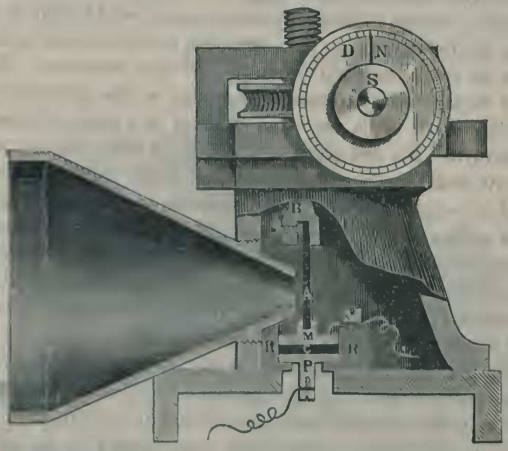


"With this instrument was used a Thomson's reflecting galvanometer on a tripod, having a resistance of three-fourths of an ohm. The galvanometer was placed in the bridge wire of a Wheatstone balance, two of the branches of which had constant resistances of ten ohms each, while of the

other two one had a constant of three ohms, and the other contained the tasimeter which was adjusted by means of the screw to three ohms. When thus balanced, if the strip of vulcanized rubber A (seen in Fig. 3), placed between the fixed point B and the carbon button C, was exposed to heat from any source, it expanded, placing pressure upon the carbon button, decreasing in this way its resistance and destroying the balance; thus allowing a current to pass through the bridge wire containing the galvanometer, the amount of this current of course being proportional to the expansion of the rubber and to the strength of the battery.

"The form of instrument here described was finished only two days before leaving for the west; hence, I was unable to test it. However, I set it up upon my arrival at Rawlins, but found that it was a very difficult matter to balance so delicate an instrument as a reflecting galvanometer with one cell of battery, through such small resistances. In fact, I did not succeed in balancing it at all in the usual way. Nor could it be balanced in any way until I devised a method which I may designate 'fractional balancing,' when it became very easy to accomplish the result and also to increase the effect by using two cells in place of a single one. This device

Fig. 3.



consisted of a rheostat formed of two rows of pins. The rows were about one-half an inch apart. A wire was connected from a pin on one row to a pin on the other row and so on, so that the current had to pass through the whole length of the wire, which was No. 24 gauge and four feet long. This was used as a shunt around the galvanometer. A copper wire connecting all the pins of one row served to reduce the resistance to zero. When the galvanometer was thus shunted, a very feeble current passed through it. If the spot of light was not at zero it was brought there by either increasing or decreasing the pressure upon the vulcanite of the tasimeter by the adjusting nut. When thus brought to zero the copper wire of the shunt rheostat was taken off of one pin, thus increasing the resist-

ance of the shunt perhaps to one-fiftieth of an ohm. The spot of light was generally deflected nearly off of the scale. The light was again brought to zero by varying the resistance of the tasimeter, and another one-half inch of wire included in the shunt, another deflection and another balance was obtained by the tasimeter. Thus by gradually increasing the delicacy of the galvanometer by increasing the resistance of the shunt and balancing at every increase, the whole of the current was allowed to pass through the galvanometer and the shunt taken off. When this point was reached the damping magnet or director was in close proximity to the case of the galvanometer. To increase its delicacy to the fullest extent it became necessary to raise the director to the top of the rod. This was done by raising it cautiously a quarter of an inch at a time, bringing the spot of light to zero each time by the tasimeter.

"In order to form some idea of the delicacy of the apparatus when thus adjusted, a preliminary experiment was made on the evening of the 27th, with the star Arcturus. The tasimeter being attached to the telescope, the image of the star was brought on the vulcanized rubber. The spot of light from the galvanometer moved to the side of heat. After some minor adjustments, five uniform and successive deflections were obtained with the instrument, as the light of the star was allowed to fall on the vulcanite to produce the deflection, or was screened off to allow of a return to zero.

"It was in this condition when the eclipse occurred. The tasimeter was placed in a double tin case, with water at the temperature of the air between the walls. This case was secured to a Dollond telescope of four inches aperture. No eye piece was used. At the moment of totality the spot of light was slowly passing towards cold. When I withdrew a tin screen and allowed the edge of the luminous corona to fall upon the rubber, the spot of light stopped, went gradually off of the scale towards heat, its velocity accelerating as it approached the end. The time required for the light to leave the scale was from four to five seconds.

"I interposed the screen and endeavored to bring the light back to zero, but I was unsuccessful. Had I known that the heat was so great I should have used a platinum strip in place of the vulcanite, and decreased the delicacy of the galvanometer by the approach of the damping magnet.

"I would then doubtless have succeeded in getting two or more readings, and afterwards by comparison with bodies of known temperature would have obtained a near approach to the temperature of the sun's corona."

Telespectroscopic Observations.

My own results, obtained with an analyzing spectroscope attached to the telescope, seem to be almost unique in this eclipse. This fact must be my apology, if any be needed, for introducing here at such length, the facts of the case as contained in my report.

The instruments and apparatus used in the observations were loaned for the purpose from the physical cabinet of the University of Pennsylvania. They consisted (1) of an equatorially mounted achromatic telescope of four inches aperture made by Jones of London ; (2) a direct vision astronom-

ical spectroscope by Merz of Munich; (3) a second direct vision spectroscope by Hoffmann of Paris; and (4) a pocket spectroscope by Geo. Wale & Co. Beside this spectroscopic outfit, a second four-inch achromatic telescope by Dollond was taken for use with the tasimeter by Dr. Edison, and a Savart, a Senarmont, and an Arago polariscope, for determining the polarization of the corona. The Merz spectroscope above mentioned is described in the "Philosophical Magazine," IV., xli., Feb., 1871. It is provided with two compound direct vision prisms, of which one or both can be used at pleasure, each consisting of five single prisms, two of flint glass with a refracting angle of 84°, and three of crown; one of these having a refracting angle of 84°, the others of 87°. The dispersive power of each of these compound prisms is about equal to that of two equilateral prisms of flint glass. The instrument has a collimating and an observing telescope, each furnished with an object glass two-thirds of an inch in aperture and four inches in focal length. The prism-tube is attached to the collimator by two centres, giving it a lateral motion about a line passing through these centres, which constitutes an axis parallel to the slit. The observing telescope is similarly attached to the tube carrying the prism. These motions serve to alter the incidence of the rays upon the surface of the prism, and also to bring any special part of the spectrum into the middle of the field. The observing telescope is provided with a positive eye-piece of an equivalent focal length of one inch, and also with a needle micrometer, having an eye-piece of one-half inch focus. The graduations upon this micrometer are strongly cut, enabling the positions and the distances of the lines measured with it to be easily read even in a faint light. The spectroscope was firmly attached to the draw tube of the equatorial telescope by means of an open frame made by Zentmayer, so that the position of the image with reference to the slit could be readily observed.

The time from the date of our arrival at Rawlins until the eclipse, was occupied in setting up the instruments, in getting them into adjustment, and in practice with them. It was found that with only one of the compound prisms of the Merz spectroscope, the slit being placed radially, it was easy to observe the lines C and F reversed in the chromosphere, and also the bright line D_3. On the morning of the day of the eclipse, the solar edge was examined for protuberances, in order to locate them in advance of totality. But a single one was noticed, this being on the south-western edge of the sun. As the time of first contact approached, the spectroscope was removed and a paper screen was attached to the draw-tube, an image of the sun being formed on this screen by means of the eye-piece; thus enabling the time of this contact to be approximately determined and the subsequent progress of the eclipse to be conveniently observed. No spots were seen under these circumstances, though this could hardly have been expected since the solar image was so small, scarcely three inches in diameter, unless the spots were of large size. As the time of second contact drew near, the spectroscope was replaced upon the equatorial. Since you deemed it of importance to pay special attention to the oxygen lines in the vicinity of G, the micrometer of this instrument

was, at your suggestion, so adjusted that one of its needle-points rested on the hydrogen line near G and the other on the line known as *h*. After the last ray of sunlight had disappeared, I took a few seconds of the precious time to observe the eclipse with the naked eye. The moon appeared intensely black, surrounded by a pinkish halo, extending to about two-fifths of a lunar diameter from the limb, and occupying the entire circumference. At two points this halo was expanded into radial streamers, one of which had parallel sides with a deeply indented or swallow-tailed end, extending westward of the sun and apparently lying in the ecliptic; the other appeared single, was on the eastern edge, and was inclined twenty degrees or more to the north of the ecliptic. The former of these streamers was traced to a distance of about a lunar diameter and a half from the edge, the latter to a somewhat less distance. No structure could be seen in the halo, but in the streamers traces of parallel rays appeared to be present. The amount of light emitted by the corona was a surprise to me. Preparations had been made for using artificial light for reading the circles, but this was found not to be at all necessary. The amount of light seemed to be nearly or quite equal to that given by the moon when ten days old. No protuberances were seen with the naked eye; nor were any streamers observed, other than those already described. A glance at the eclipsed sun was then taken through the finder of the equatorial. The magnifying power being low, the corona presented much the same appearance as to the naked eye; but the streamers showed much more distinct evidences of a radiated structure and a pale rosy protuberance was observed on the south-western edge of the dark disk. This was undoubtedly the same prominence which was observed previous to totality.

Turning my attention now to the spectroscope, upon the slit of which the coronal image had already been brought by means of the finder, the slit being placed radially, the first glance through the instrument showed me a bright, but an absolutely continuous spectrum. The region under examination was of course that portion of the spectrum which had been placed before totality between the needle-points of the micrometer. Totally unprepared for so unexpected a result, I moved the observing telescope so as to bring the green portion of the spectrum into the field, expecting certainly to see 1474 K, and by the appearance of this line to determine whether my instrument was out of adjustment; and if it were, to adjust it again. But no bright line was there; the green region appeared as continuous as the blue. I then gradually closed the slit—which had been previously adjusted on the solar spectrum so that the line D appeared nebulous on its edges—thinking that I might in this way improve the definition, but with no better results; no bright lines could be seen. To my great surprise, however, when the slit was thus narrowed, the region which was then under examination, that extending from *b* to G, appeared filled with dark lines on the brighter background, these dark lines being readily recognized from their general appearance as the solar lines of Fraunhofer. Still intent on getting bright lines, I opened the slit again gradually, moved the observing telescope over the entire length of the spectrum from red to violet, re-

peating the operation three times and varying the width of the slit from time to time in each region; but not a single bright line could be detected. I then requested you to come and take a glance through my spectroscope, as had been previously agreed; saying that although I could see dark lines and a continuous spectrum, I was unable to detect a single bright line, and knew not what to make of it. You were then looking at the eclipse through your ingenious little telespectroscope of two inches aperture. You came to my instrument, looked at the spectrum, moved the observing telescope over its whole length and remarked that the results in my spectroscope agreed entirely with those in yours, and that in both the spectrum appeared continuous, showing no bright lines whatever.

My mind being thus relieved, I took my place again at the spectroscope, and this time, placing the slit tangential to the moon's limb, I moved the observing telescope from end to end of the spectrum, opening and closing the slit at intervals; but the spectrum appeared as continuous as before. Again the image was adjusted so that the slit was once more radial; and this time on a still different portion of the corona. On examining again the spectrum, no bright lines appeared, except once for an instant, when the slit passed over the small chromospheric prominence already noticed. Warned by Mrs. Draper's clear and distinct counting that the precious 165 seconds had two-thirds gone, I decided to devote the time still remaining to a more careful observation of the dark Fraunhofer lines. Now, for the first time, as I adjusted the width of the slit and its position on the corona with more care, I observed that these lines did not pass clear across the field, but were of a length corresponding to the width of the coronal image on the slit. At the base of the spectrum, which corresponded to the base of the corona, they appeared bright and sharp; certainly quite as much so as in the light of the moon similarly condensed; though the continuous spectrum which formed their background was relatively brighter than in moonlight. There was no difficulty in identifying them as Fraunhofer lines from their general appearance and position; but some of them could be identified beyond question. Such were *b* and F, which were especially distinct, D, E and G, which were considerably less so. They faded gradually out from the base of the spectrum upward, appearing to end where the continuous spectrum of the corona was limited above. While thus employed, a flash of sunlight told us that totality had ended and that the solar eclipse of 1878 was over.

In discussing the results of the spectroscopic observations which have now been detailed, I am, in the first place, quite at a loss to account for the fact that no bright lines were seen by me, notwithstanding the persistent efforts made to get them. The failure to observe them can be accounted for, as it would seem, only on the ground that with the dispersive power employed, the bright lines were too faint to be seen on the much brighter background of the continuous spectrum.

The lessons to be drawn from these spectroscopic observations appear to be few and simple. The absence of bright lines, or at least of any which

were at all brilliant, proves clearly the absence in the solar coronal region of any considerable mass of incandescent gas or vapor; which shining by its own light would of course give a bright line spectrum. The presence of Fraunhofer lines in the coronal spectrum shows conclusively the presence of reflected sunlight in the light of the corona and goes to establish the theory long ago suggested, that masses of meteoric matter raining down upon the solar surface from all directions, reflected to us the light of the sun and were therefore the essential cause of the coronal phenomena. And, finally, the fact of the increased brightness of the continuous spectrum, as compared with the intensity of the dark lines of Fraunhofer, goes to strengthen the probability that there is still other light in the corona which comes to us from the incandescent liquid or solid matter of these incandescent meteoric masses. These conclusions, deduced very simply from my own spectroscopic results, agree completely, I am happy to find, with those drawn from your most excellent photographs, as well as from the ingenious heat-measurements of Dr. Edison and the polariscopic determinations of Dr. Morton.

General Conclusion.

The general conclusion then, arrived at by the observations of our party upon this eclipse—a conclusion to which all the results point with singular unanimity—is that the solar corona consists of a mass of meteoric bodies falling in from space upon the solar surface, which meteors being intensely heated by the resistance encountered at their enormous velocity, as well as by radiation from the sun, become highly luminous, and emit a light which gives a continuous spectrum. Moreover, this mass of incandescent meteors is shown not to be equally extended in all directions around the sun, but appears to be ellipsoidal or at least spheroidal in form. That the larger part of the coronal light comes from the incandescence of these meteors, there can apparently, be but little doubt. But a considerable portion of it appears to have quite a distinct origin, and to be due to the reflection of solar light by these solid or liquid masses. Hence the appearance of the dark solar or Fraunhofer lines in the spectrum. A third, and in this eclipse an extremely small portion of the light of the corona, would seem to be due to incandescent gaseous matter, either injected into it from below, or produced from the meteoric masses themselves by the intense heat. This portion it is which gives the bright line spectrum, as feeble in this eclipse as it was strong in previous ones. Of the material composing this gas, there is yet, as it would appear, no indication.

From what has now been narrated, it must be conceded that the Draper Eclipse Expedition was singularly and exceptionally fortunate. No small part of this good fortune is due, as we believe, to the courtesy and liberality of the railroad and express companies over whose routes either the party or their instruments traveled. I desire to mention especially, in this connection, Col. Thos. A. Scott and Mr. Frank Thomson, of the Pennsylvania

Railroad; Mr. Henry Keep and Mr. M. L. Sykes, of the Chicago and Northwestern Railroad; Mr. Sidney Dillon and Mr. Jay Gould, of the Union Pacific Railroad; Mr. William H. Fargo, of the American Express Company; Mr. Frederic Lovejoy, of Adams' Express Company, and the Superintendent of the Union Pacific Express Company. The cordial appreciation by these gentlemen of the fact that the work in which we were engaged was one of a purely scientific character, and as such was one to which every reasonable facility should be furnished, was as gratifying to us as it was honorable to them. I should fail to do exact justice were I to omit mention of the service rendered us by Mr. J. J. Dickey, the Superintendent of the Union Pacific Telegraph; Mr. E. Dickenson, Superintendent of the Laramie Division; Mr. R. M. Galbraith, Superintendent of the Repair Shops at Rawlins; Major Thornburgh, Commanding Officer at Fort Fred Steele, with Capt. Bisbee and Surgeon De Witt, his associates in the service; Mr. Lawrence Hayes, of the Railroad Hotel, and to Mr. J. B. Silvis, of the photographic car. "Of the citizens of Rawlins," says Dr. Draper, "it is only necessary to say that we never even put the lock on the door of the observatory, and not a thing was disturbed or misplaced during our ten days of residence, though we had many visitors."

The agreeable party, the pleasant surroundings, the charming weather, the kindness of friends, and above all, the capital success of the observations, make the Draper Eclipse Expedition an exceedingly pleasant memory to us all.

Notes on a series of Analyses of the Dolomitic Limestone Rocks of Cumberland County, Pa., made by Messrs. Hartshorne and Hartranft in the Laboratory of the Second Geological Survey of Pennsylvania. By J. P. Lesley, State Geologist.

(*Read before the American Philosophical Society, October 18th*, 1878.)

At a meeting of the American Philosophical Society, Dec. 20, 1877, I described the progress of an elaborate investigation which I had instituted for the purpose of determining whether or not any fixed or rational order of deposition could be observed in our Lower Silurian, or Siluro-Cambrian Magnesian Formation (No. II).

I selected a fine exposure made by the rock cut of the Northern Central Railroad, on the west bank of the Susquehanna river, opposite Harrisburg, where a consecutive series of the beds, all conformable and all dipping regularly about 30° to the southward, afforded a good opportunity for collecting two sets of specimens for analysis, one at the bottom and the other at the top of the cut; and great care was taken to survey the cut, mark the beds (from 1 to 115) and range the specimens in two parallel series: so